UNITED STATES DEPARTMENT OF AGRICULTURE

SYLLABUS 20

Contribution from the States Relations Service
A. C. TRUE, Director

In Cooperation with the Bureau of Plant Industry
W. A. TAYLOR, Chief

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ILLUSTRATED LECTURE ON THE PRODUCTION OF ALFALFA EAST OF THE NINETY-FIFTH MERIDIAN

By

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SYLLABUS 20—ILLUSTRATED LECTURE ON THE PRODUCTION OF ALFALFA EAST OF THE NINETY-FIFTH MERIDIAN,[1]

By H. L. Westover, *Scientific Assistant, Forage Crop Investigations, Bureau of Plant Industry*, and H. B. Hendrick, *Assistant in Agricultural Education, States Relations Service.*

INTRODUCTION.

View. Alfalfa is one of the most important forage crops in the United States. Its value has been recognized for many years in the semiarid regions of this country, where, especially under irrigation, its yield has been bountiful. A growing knowledge of its feeding value and of the special requirements for its successful culture has centered much attention upon the production of alfalfa in the East and South, where the acreage and tonnage of this crop have increased considerably in recent years.

1 According to the United States census for 1909 the alfalfa harvested in the States east of the 95th meridian was 278,516 acres, yielding 669,292 tons of hay. The Bureau of Crop Estimates placed the yield of alfalfa hay for 1915 for this region at 3,079,000 tons. Alfalfa is now grown to some extent in every State in the Union.

HISTORY.

2 Alfalfa is believed to be the oldest plant cultivated solely for forage. History seems to show that it was first cultivated in Persia, from which country it was carried to Arabia, where the plant was first called alfalfa, which means "the best fodder." The Persian invasion of Greece about 470 B. C. caused alfalfa to be introduced into that country, where it was afterwards cultivated. From Greece the plant was carried later to Italy, from which country it spread through France, Spain, England, and probably Germany. The Spaniards brought

[1] This syllabus has been prepared by direct cooperation between the Division of Forage Crop Investigations of the Bureau of Plant Industry, as regards subject matter, and J. M. Stedman, Farmers' Institute Specialist of the States Relations Service, as regards pedagogical form. It is designed to aid farmers' institute and other extension lecturers in presenting this subject before popular audiences. The syllabus is illustrated with 51 lantern slides. The numbers in the margins of the pages refer to the lantern slides as listed in the Appendix.

54390—16——1

View. alfalfa to Mexico and the South American countries, and from Chile it was taken to San Francisco from 1851 to 1854. This date marks the beginning of the extension of alfalfa over the irrigated sections of the Western States.

The early American colonies made several attempts to grow alfalfa, but without great success. George Washington grew trial plats of alfalfa on his Virginia farm, and Thomas Jefferson gave considerable attention and care to its cultivation. Their efforts, however, proved unsatisfactory, since they did not understand all of the requirements for the successful growth of the plant.

DESCRIPTION.

Alfalfa is a deep-rooted, hardy, leguminous forage plant belonging to the family which includes beans, peas, and
3 clover. It is a perennial, living for several years under favorable conditions. The leaf of alfalfa is divided into three leaflets, the middle one of which has a short stem, differing in this respect from red and alsike clovers, in which the center leaflet is attached directly at the base. This difference in the two plants readily enables one to distinguish alfalfa from red clover when the plants are very young. As the plants become older the leaflets of the alfalfa become more elongated than in the clovers. The flowers of common alfalfa are violet
4 to purple in color and arranged into a slightly elongated flower cluster, which becomes more or less headlike as the
5 flowers mature. The seed pods are small, slightly hairy, and spirally coiled in two or three turns, several seeds being contained in each pod. The seeds are kidney-shaped, and about the size of the seeds of red clover, but are easily distinguished
6 from them by their uniform light olive-green color as contrasted with the purple and yellow clover seed; but, unlike red clover, the seeds vary considerably in shape.

Alfalfa occupies the same place in western agriculture that the clovers fill in the eastern third of the United States. As a hay crop alfalfa is to be preferred to red clover or cowpea hay wherever it can be successfully produced. It is somewhat superior to either clover or cowpeas in feeding value, while under favorable conditions the number of crops alfalfa produces in one season makes the total yield per acre greater than that of either of these crops.

One specially important characteristic of alfalfa is its long
7 tap-root system, which often extends several feet into the soil. This enables the plant to reach moisture and plant food in the soil which can not be secured by the more shallow-rooted crops.

CLIMATIC RELATIONS.

The wide distribution of alfalfa throughout the world shows the remarkable ability of the species to adapt itself to various climates and conditions. The climate of a country, however, does influence the success with which alfalfa can be grown. Carefully conducted experiments have shown that adapted strains and varieties of alfalfa will withstand, other conditions being favorable, very low temperatures. Practically no injury from summer heat has been recorded in dry climates, but high temperatures combined with much moisture in the atmosphere are so injurious that it is difficult to grow the crop successfully under these conditions. Regions having a semi-arid climate can produce alfalfa successfully in nearly all types of soil and through a wide range of temperatures. In moister climates, such as the eastern United States, it is not easy to succeed except where the soil conditions are favorable. Marked success has been obtained on certain soils in the South where the annual rainfall exceeds 50 inches. View.

SOIL REQUIREMENTS.

A deep, fertile, well-drained, nonacid soil is required. 8
Loam soils with open subsoils are best for alfalfa, but it may be grown on soils of almost any texture, from sandy or gravelly loams to heavy clays. The proportion of failures, however, is apt to be considerable on deep, porous sands or sands underlain by gravel. It is highly essential in any case that the soil be well supplied with decaying vegetable matter and plant food. It is practically useless to sow alfalfa on thin soils where the bed rock approaches the surface; on land which is underlain at comparatively shallow depths by hardpan; or in locations where the subsoil is so compact that the roots can not penetrate it. It is of prime importance also that an alfalfa field shall be located where the slope is sufficient to carry off the surplus water and that the water table shall remain at a sufficient depth from the surface. In porous soils that conduct water readily, standing water at 4 or 5 feet is sometimes injurious.

The formation of ice on the surface of fields is fatal to alfalfa. This condition is most apt to occur on fields that are level or that contain pockets. Rich river or creek bottom lands are often well suited to the crop, provided they are well drained. Prolonged overflows are nearly always harmful, but are least injurious if they occur during winter or early spring 9
when growth is practically dormant. Clay hillsides of considerable slope are frequently water-soaked and poorly drained

View. because of the close texture of the soil. Seepage areas from outcropping rocks or other causes often occur on hillsides, also, making underdrainage of such areas necessary. In examining a tract of land for alfalfa frequent borings should be made with a soil auger to determine the character of the soil and subsoil as well as the drainage conditions. This instrument will usually be of greater value in determining the adaptability of a particular tract to alfalfa than a chemical analysis of the soil. A
10 common $1\frac{1}{4}$-inch auger with the shank lengthened and a suitable crossbar for a handle is practical for this use.

Limestone soils in general are particularly well suited to alfalfa, but even such lands are frequently acid and require liming to grow this crop successfully.

PRECEDING CROP.

When alfalfa is once started under favorable soil conditions, weeds, including perennial grasses, will likely prove its most dangerous enemy. This is one reason why sod land is not recommended for this crop. On account of the danger from weeds it is usually best to precede the alfalfa for one or two
11 years with a clean-cultivated crop such as truck, sugar beets, beans, potatoes, or corn. Where late summer or fall seeding is practiced, canning peas, early potatoes, early sweet corn, and early varieties of soy beans, when cultivated, furnish an opportunity for removing a crop in time to seed alfalfa the same season. Where crimson clover is used as a cover crop, following a cultivated crop, the soil is usually in good condition
12 to prepare for alfalfa after harvesting the crimson clover the following spring for hay; or, when needed, the crimson clover may be turned under for soil enrichment, after which the ground may be prepared for alfalfa. In this case there must be a sufficient period of time between plowing and sowing to permit partial decomposition of the material turned under, and a sufficient working of the soil to bring about the capillary movements of moisture between surface soil and subsoil. In sections where small-grain crops like winter wheat, rye, or barley can be gotten off in time to permit proper preparation of the land for seeding the same season, successful stands of alfalfa may be secured following these crops, provided the land has been treated previously in such a manner as to destroy the weeds. The principal objection in some sections to seeding after any of these crops is the possible lack of moisture in the soil due to the demands of the preceding crop. In several of the Northeastern States oats and field peas grown for hay may be used to good advantage as a crop to precede alfalfa.

PREPARATION OF THE SEED BED.

The tender nature of the young alfalfa plants requires that the soil be in excellent tilth at the time of planting. Many of the failures to secure a good stand may be traced directly to the improper condition of the seed bed. The aim should be to get the soil finely pulverized, thoroughly compacted, and comparatively free from weeds. The surface 2 or 3 inches should be fine and loose, and below this it should be sufficiently firm to favor the capillary movement of water, yet porous enough to permit good drainage and free circulation of air through the soil. Fall plowing is desirable in sections where early summer seeding is practiced. If fall plowed, the land should be thoroughly disked as soon as it will work up well in the spring, and should then be harrowed until seeding time at intervals sufficiently frequent to keep down the weeds and to make a perfect seed bed. Where land is plowed in the spring for alfalfa, at least four to six weeks should intervene between the time of plowing and seeding, during which time the land should be harrowed every 10 or 12 days to keep down the weeds and to conserve the moisture. Where the soil is inclined to be too loose or when there are any clods, the roller pulverizer is an excellent tool to use. When alfalfa is to follow winter wheat or other small-grain crops, a thorough disking, followed by frequent harrowings, will often be all that may be required, provided the land is worked shortly after the grain is removed. When plowing in this case is necessary, the preparation of the seed bed will often be facilitated by disking ahead of the plow and by following the plow at once with a pulverizer and harrow. On land that has been in an early maturing cultivated crop, such as potatoes, peas, sweet corn, or soy beans, no other preparation will be needed than the necessary harrowings.

View. 13 14 15

LIMING THE SOIL.

Probably no other field crop requires lime to such an extent as does alfalfa, and with the exception of rather limited limestone areas, practically all of the soils of the United States east of the ninety-fifth meridian require liming for the best development of this crop. Even in regions underlain by limestone, applications of lime may be beneficial, as the soils in such locations may not have been derived from underlying formations, or if they have been, a large amount of the lime originally present in the soil may have been lost through leaching.

16 17

The most common test for determining if soil is acid or sour is by means of blue litmus paper, which can be obtained at a

View. very small cost from nearly every druggist. A small quantity of moist soil from the field is compacted into a ball, the ball
18 broken into halves, a strip of the litmus paper laid across one part, and the parts pressed firmly together again. After an hour or so the ball of soil should be again broken apart and
19 the paper removed. If the paper shows a decided pink color the sample of soil is acid. It will be well to test samples taken from both the surface soil and the subsoil. If there is some doubt as to the necessity for liming, the most practical and satisfactory way to determine this point is to sow a small field
20 to alfalfa, liberally liming a part of it, and leaving a part unlimed. The growth of alfalfa in the two parts will be a good test of the need for lime.

Burned lime, slaked or hydrated lime, or finely ground limestone and oyster shells may be used. Experiments have shown little difference in the final results obtained from the use of the different forms of lime. Burned lime or hydrated lime may give quicker results, but the ground limestone will finally give the same benefit. The first-named forms are caustic, and it is not advisable to mix or plow under burned lime with stable manure containing much straw, as a burning of some of the manure is apt to result.

21 For correcting acidity 1 ton of burned lime is practically equal to 1½ tons of slaked lime or 2 tons of ground limestone, in case all three forms are of equal grade of purity. The amount of lime required will depend, of course, upon the needs of the soil. In general, not less than the above amounts per acre in their respective forms should be applied to the soil for alfalfa. The farmer should use the form of lime that is cheapest, based upon their relative values for correcting acidity. Where the consumer pays the freight he should bear in mind the transportation charges, together with the expense of hauling and spreading, based upon the relative amounts per acre of the different forms which are equivalent in neutralizing acidity in the soil.

Lime should be applied after plowing, and preferably three or four weeks before seeding, in order that it may become from frequent harrowings thoroughly incorporated with the soil. It is often practical, especially when using ground limestone, to apply the lime to the crop preceding, in order that there may be time for it to become thoroughly available for the
22 alfalfa. Lime may be applied with a manure spreader, or fertilizer distributor, a lime distributor, or even by hand. Any method that spreads lime uniformly and at low cost is

satisfactory. The fertilizer distributor will spread only about 1,000 pounds per acre. When the manure spreader is used for lime, a thin layer of fine straw or barnyard litter should be placed upon the table of the spreader before loading the lime. Burned lime must be ground before it can be spread with either the fertilizer distributor or the lime distributor. The caustic effect of both burned lime and slaked lime makes them disagreeable to handle. The regular manufactured lime distributor is the most satisfactory tool to use for spreading, but where lime is used only for small fields of alfalfa, it might not prove practical to purchase one of these machines. View.

FERTILIZING.

Good barnyard or stable manure is the most satisfactory fertilizer. The application of manure should be liberal. If barnyard or stable manure is not available and the soil has need of vegetable matter, some green-manure crop may be used to good advantage. Crimson clover, a mixture of rye and winter vetch, and cowpeas are good green-manure crops. Several weeks should elapse between plowing under a heavy green-manure crop and seeding. When well established, alfalfa is able to get much of its nitrogen from the air, but it requires large amounts of phosphoric acid and potash. Most clay soils, however, seem to supply potash liberally, and heavy applications of potash salts have not been profitable except in certain limited areas. In general, a combination of muriate of potash, 75 to 100 pounds, acid phosphate, 350 to 500 pounds, and nitrate of soda, 50 to 75 pounds per acre, gives the best results for this crop. While this combination has given quite satisfactory results, it is doubtful if either potash or nitrate of soda can be profitably used when unusually high prices for these materials prevail, and under such conditions an application of 350 to 500 pounds of acid phosphate can be used alone to very good advantage. The cheapest and most satisfactory method by which the consumer may obtain the desired combination is to purchase the various ingredients and mix them himself in their proper proportions. This fertilizer mixture should be applied before the last one or two harrowings, preceding the sowing of the alfalfa. Good stable manure is one of the most satisfactory top-dressings. It should be applied in the late fall or early winter and distributed evenly. Where manure is not available, 300 to 400 pounds per acre of acid phosphate will nearly always give good results. 23 24

INOCULATION.

View.

25 Nitrogen-fixing bacteria should be provided, unless the soil is known to be supplied naturally with these germs.
26 Inoculation may best be accomplished by scattering over the area to be seeded surface soil taken to the depth of 4 or 5 inches from another field upon which the crop has been previously successfully grown. The soil should be broadcasted, at the rate of from 250 to 500 pounds per acre, and harrowed in immediately. The spreading should take place on a cloudy day or late in the afternoon, as the sun's rays are destructive to the germs. Soil from the roots of sweet-
27 clover plants also will inoculate alfalfa. Care should be taken to avoid introducing noxious weeds or fungus diseases. The practice of sowing a small quantity of alfalfa with the regular seeding of clover or other hay crops each year for a few years before it is intended to devote the land to alfalfa has in some cases apparently introduced sufficient bacteria for inoculating the succeeding crop of alfalfa. Another method which may be used is that of inoculating seed with an artificial culture, a limited quantity of which can be procured from the United States Department of Agriculture, free of
28 charge. Full instructions for use accompany each bottle of culture. This culture is produced also for distribution by the laboratories of several of the State agricultural experiment
29 stations. The combined use of the soil and the artificial culture gives added assurance of successful inoculation and is recommended when both can be readily obtained.

SEED.

Alfalfa seed should be selected with considerable care. The variety, the original source of the seed, its purity, and its vitality each should be considered. The principal commercial varieties of alfalfa grown in this country are the common or ordinary, the Turkestan, and the Grimm. A large percentage of the alfalfa grown in the United States is ordinary alfalfa. Where alfalfa has been grown under certain conditions for a considerable time there is a tendency through elimination to produce a type presumably best adapted to the conditions under which it was developed. Thus seed from various sources is frequently designated by the State in which it was produced. In sections where winterkilling is not a factor the ordinary types are generally recommended in preference to the so-called hardy alfalfas, as they generally produce somewhat heavier yields.

Most alfalfa seed, not American grown, is imported from Turkestan. In appearance the Turkestan alfalfa closely resembles the common variety. While certain forms have under some conditions proved slightly more resistant to cold and drought, on the whole it is decidedly inferior to the common, especially in humid sections. Grimm alfalfa is an important variety and is the result of a natural cross and natural selection between the common variety and the yellow-flowered or sickle alfalfa. In appearance it does not differ materially from the ordinary strain. It may be distinguished, however, by the variegation of some of its flowers, which include shades of violet, yellow, and other hues; by the tendency of the tap roots to branch; and by the low set and spreading character of its crowns. The hardiness of Grimm alfalfa commends it to certain sections of the country where the winters are severe.

View.

30

Seed production has not proved a profitable undertaking in the eastern part of the United States, owing to the fact that the seed sets very sparingly under humid conditions. Occasionally, when the weather is specially favorable, fair crops have been secured, but the chances for a complete failure are so great that a farmer can hardly afford to make a regular practice of attempting to produce seed. Consequently, most places east of the ninety-fifth meridian must depend on distant sources for seed, in which case it is generally advisable to secure western American seed produced in about the same latitude as is the section where the seed is to be sown.

However, the United States uses more alfalfa seed than it produces. In 1913, approximately 37,500,000 pounds of alfalfa seed were used in this country for domestic seeding purposes, 6,000,000 pounds of which were imported. The type of seed chiefly imported into this country is the Turkestan. European investigators, as a result of variety tests, consider the Turkestan alfalfa as an inferior type, and the commercial Turkestan seed, therefore, is little used in the alfalfa-growing regions of Europe. Since imported seed is usually sold in this country on the basis of appearance, regardless of the place of origin, Turkestan seed, the lowest priced alfalfa seed in the European markets, is the type now most largely imported.

In this country, likewise, the commercial Turkestan alfalfa has not proved a success. It is relatively short lived, not particularly hardy, and recovers slowly after cutting, thus reducing the hay yield. It is particularly unsuited to the humid eastern section of the United States.

View. Commercial Turkestan alfalfa seed can not be recommended for general use in this country. This seed nearly always con-
31 tains the seeds of Russian knapweed, a pernicious plant similar in manner of growth to quack grass, Johnson grass, and Canada thistle. Its seeds are slightly larger than alfalfa seed, symmetrical in form, slightly wedge-shaped, and of a chalky white color, which makes them especially conspicuous. Their size makes it practically impossible to remove them by any machine method, and the seeds of the knapweed, therefore, serve admirably to identify commercial Turkestan alfalfa seed.

Adulteration of alfalfa seed sold in this country has occurred at times when the price of alfalfa seed was high. The seeds of yellow trefoil and of bur clover have been most com-
32 monly used for this purpose. The seed of yellow trefoil is darker green and slightly different in shape from alfalfa seed, while bur-clover seed is slightly larger and lighter in color than the alfalfa. With some experience both can be distinguished from alfalfa seed by examination through a hand lens.

Comparatively few weed seeds are found in the best grades
33 of alfalfa seed. The low grades, however, which are mostly screenings, often carry large numbers of weed seeds. The analysis some years ago of sample No. 21006 of the United States Department of Agriculture showed 6.8 per cent of weed seeds, or nearly 32,500 per pound, of which 5,490 were dodder. Of all weeds dodder is the most destructive to the alfalfa plant. It is a parastitic plant, having no leaves. Its fine yellow stems wind around and cling in a tangled mass to the
34 host plants. After germinating in the ground the dodder seed sends up a slender stem which attaches itself to the alfalfa plant, after which the root soon dies, leaving the dodder stem to grow and thrive as a parasite on the juices of the alfalfa until it matures seed or kills the alfalfa. Dodder occurs wherever alfalfa grows except in the extreme Northern States. It is very destructive when thoroughly established. It can be quite satisfactorily controlled by mowing the field and burning the cutting. Another method of control that has given good results is to sprinkle the infected area with kerosene as soon as the dodder appears and burn over the area immediately after. This will kill the dodder and seldom
35 injures the roots of the alfalfa. The larger seeds of dodder are nearly as large as the smaller alfalfa seed and so are difficult to screen out.

It pays as a rule to buy the highest grade of seed, even though it is the highest priced. In the low grades of alfalfa

View.

the seed that will grow costs more per pound than that in the high grades. Samples from different firms should be compared, and the best quality of seed should be selected. Alfalfa seed may be considered good grade when it contains not more than 2 per cent of impurities and when 90 to 95 per cent of it will grow. It is well to order samples of seed from a reliable seedsman the winter before it is to be sown and to test these samples carefully, or have them tested, for purity and germination. By securing samples of seed early one can have reasonable assurance of being able to secure seed from the sample which gave the most satisfactory results from the tests before all of the seed from such sample has been sold by the seedsman. 36

The hand lens will be found very useful in detecting dodder and other weed seeds. The general quality of unadulterated seed can be estimated on the basis of color. Fresh seed is light olive green and gives a bright glossy surface when rubbed with the hand. Alfalfa seed which is of any shade of brown is questionable. One should not purchase seed when the sample contains any considerable percentage that is discolored. 37

The percentage of seed that will grow can be easily determined by means of a simple tester. The seed should be thoroughly mixed, after which 100 or 200 seeds should be counted out. The seeds should be placed between two pieces of blotting paper or two folds of a piece of flannel cloth, care being taken that the seeds do not touch one another. The seed container should then be put on a plate, well moistened without saturating, covered with another plate inverted, and the tester then placed where the temperature can be kept at about 70° F. After about three days the sprouted seed should be counted and removed each day until about the sixth, when most of the good seeds will have sprouted and the percentage that will grow can be determined. Some hard seed are occasionally present in a sample. These may be alive, but they require additional time for germination. In the case of Grimm alfalfa as much as 35 per cent of the seed is frequently hard. 38

The Seed Laboratory of the United States Department of Agriculture, and also the seed laboratories of many of the experiment stations of the State colleges of agriculture, will make without charge tests of alfalfa seed and other seeds both for purity and germination. The test for purity determines the percentage of pure seed and weed seeds, including dodder. Samples sent to the department should be addressed to the Seed Laboratory, United States Department of Agriculture, Washington, D. C. The name and address of the seller, the

View. year and place of growth, the price paid, and the name and address of the sender of the seed should accompany the sample in so far as this information can be given.

SEEDING.

The amount of seed that is required varies with the perfection of the seed bed, the character of the soil, the grade of seed used, and the kind of weather at the time of seeding. In general, from 20 to 30 pounds per acre should be used, depending upon the conditions given above. A comparatively heavy seeding generally gives a more uniform stand than a light seeding and helps to keep down the weeds. The plants will never be thicker than the first stand, for some plants may die but no new ones will start. The seed may be drilled or else seeded with some kind of broadcast seeder and then covered with a smoothing harrow or weeder, care being taken not to cover them deeper than 1 inch on the heavier textured soils or deeper than 1½ inches on the lighter soils. In broadcasting, a more even stand may be secured by sowing one-half the
39 amount of seed one way and the other half at right angles to the first seeding. A higher percentage of germination is secured as a rule when the seed is put in with a drill, and the rate of seeding, therefore, may be somewhat less than where broadcasting is practiced.

The time for seeding depends much upon the region. In general, the best seeding time for the groups of States including Michigan, Wisconsin, and Minnesota; New England and New York; and Pennsylvania, West Virginia, northern Maryland, and northern New Jersey is from the last of June to the middle of August, depending upon the moisture and soil conditions. Early spring seedings, as a rule, have not proved successful, while seedings later than the middle of August in these sections are apt to afford too short a period of good growing weather before winter sets in for the plants to become thoroughly established. The best time of seeding for the States of Ohio, Indiana, Illinois, Iowa, Missouri, and Kentucky is about the middle of August, and for southern New Jersey, southern Maryland, Delaware, Virginia, Arkansas, Tennessee, and the Gulf States from the middle of August to the middle of October, depending upon the latitude. The sowing should always be done sufficiently early to permit of a good top growth of the plants before winter sets in.

While good results are under some conditions secured with a nurse crop, its use can not be generally recommended

When winter wheat, rye, or barley are used as a nurse crop, they should be removed early before maturing, in order that sufficient moisture may be left in the soil to carry the alfalfa through the dry weeks of midsummer. View.

TREATMENT OF THE STAND.

Spring and early summer seedings, unless the weeds threaten to choke out the young plants, should not be clipped until they are 12 to 15 inches high and beginning to bloom. The cutter bar of the mower should be set high, as the alfalfa is likely to be injured if cut low. If the first cutting is light, it may be left on the land as a mulch; if heavy enough to smother the alfalfa plants, it should be removed. Late summer seedings will ordinarily need no further treatment until the following season, when three or four cuttings may be expected. The last cutting of a season in all cases should be early enough to permit sufficient growth for protection against winter. When for any reason alfalfa turns yellow it should be cut immediately and removed from the field. A careful examination at such a time may indicate a lack of effective inoculation, disease, or the need of lime. Yellowing sometimes occurs, however, when all of these conditions are apparently favorable to the growth of the alfalfa. 40

Very thin or patchy stands of alfalfa sometimes result from poor seed, winter freezing or pulling, or from fungus diseases. Attempts to thicken and improve such stands by any method of reseeding have usually proved unsuccessful. It is best in such cases to plow and prepare the seed bed anew, after which the alfalfa should be sown again. 41

CUTTING AND CURING.

In general, alfalfa should be cut for hay when the young shoots at the bases of the plants first appear. If these new shoots become long enough to be cut off by the mower, the new crop may be badly damaged. The blossoms often appear simultaneously with the new young shoots, but blossoms alone are not a safe guide to the time for cutting. In the early springtime, especially when there has been considerable moisture, the new shoots often make a good growth before the first blossoms appear. In cuttings after the first, the alfalfa often may be in full bloom by the time the new shoots first appear, while in times of very dry weather the field may pass full bloom and the stalks of the plants may become woody before the new shoots have made any appreciable growth. The new shoots 42

View. and the blossoms together must be the final guide in cutting alfalfa for hay.

After cutting, and as soon as the alfalfa is thoroughly wilted in the swath, it should be raked into windrows. A side-
43 delivery rake is the best tool for this purpose, although the common rake is very satisfactory. When there is little danger of rain the hay will cure fairly well in this condition and may be taken directly from the windrow and placed upon a wagon for hauling. The best way, however, to cure alfalfa is to cock the hay soon after raking, leaving it in the cock until cured.
44 In humid sections canvas covers to place over the cocks while the hay is curing are sometimes a good investment. Care should be taken to handle the alfalfa hay so as not to lose leaves, as these contain considerably more than 50 per cent of the feeding value of the hay.

Alfalfa hay when cured should be stored so that it will not become damaged and lose much of its feeding value. In humid
45 climates, especially, it is economical to house alfalfa hay. If a barn or shed is not available for this purpose, then at least a roof of some kind should be provided to protect the hay. When alfalfa is stacked the center of the stack should always be kept full and well packed during the whole time of building, and the top of the stack should be well covered with canvas, marsh hay, or some kind of fine grass which will turn water, and then be weighted to resist the effect of the wind.

YIELD.

According to the Thirteenth Census of the United States the average yield of alfalfa hay for the year 1909 upon all farms reporting east of the ninety-fifth meridian was 2.4 tons per acre. However, good fields of alfalfa within this area ordinarily will produce about 1½ tons per acre of cured hay at the first cutting and from ¾ to 1 ton per acre at each subsequent cutting.

CULTIVATION.

In many States of the section of country under consideration certain weeds come in during the growing season which make it impossible for alfalfa to hold its own for many years unless some means are used as a check for the weeds. Blue-grass and crab grass are especially harmful to alfalfa in the
46 areas where they grow abundantly. In such sections the cultivation of alfalfa fields has in some cases apparently been helpful. A modified form of the spring-tooth harrow is the best tool for this purpose. The blades of the teeth from just above the cutting point are flattened for about 6 inches of their

length. This harrow cultivates the soil and destroys weeds without cutting any considerable furrow or throwing much earth over the crowns of the alfalfa plants. Disk harrows, spike-tooth harrows, and other tools are sometimes used to cultivate the crop, but the alfalfa harrow is preferable. No implement which will seriously bruise the crowns of the plants should be used to cultivate an alfalfa field. When the crowns are mutilated disease may injure or kill the plants. View.

The greatest need for cultivation is generally after cutting the first crop of hay of each season. Cultivation at this time will frequently destroy many weeds and will conserve moisture for the growth of the next crop. This cultivation of the alfalfa should take place as soon after cutting as possible and before the new shoots have made any considerable growth. 47

FEEDING VALUE.

The high feeding value of alfalfa is now so commonly known that no farmer engaged in dairy farming or in general live-stock farming would fail to grow it if he could be assured of success at a reasonable expense. Alfalfa, either as a green crop or as cured hay, is one of the most highly nutritious and palatable feeds for all classes of farm animals. Chemical analyses and experimental feeding results both show good alfalfa hay to approximate in value equal weights of common- 48
grade wheat bran for feeding. For dairy cattle feeding, alfalfa hay is therefore substituted to a considerable extent for the 49
more expensive wheat bran. It is also used to a large degree in beef-cattle rations, and is often fed to hogs and chickens 50
with profit. Work horses and mules relish alfalfa hay, but some care should be exercised not to feed it in excess to these animals. Alfalfa makes splendid pasture, but its use in this way is accompanied by danger from bloat. However, in the part of this country east of the ninety-fifth meridian alfalfa is considerably damaged by pasturing, and it is a question 51
whether one can afford to pasture a good field of it in this section.

APPENDIX.

LANTERN SLIDES.

No. of view.

1. Map showing tonnage and distribution of alfalfa.
2. A good field of alfalfa.
3. Single alfalfa plant, showing leaves.
4. Alfalfa plant, showing flowers.
5. Seed pods of alfalfa.
6. Alfalfa seed and red clover seed.
7. Root system of alfalfa.
8. Poorly drained soil. Alfalfa requires better drainage than wheat. Drainage system has now been established.
9. Alfalfa killed by standing water.
10. Soil auger.
11. A clean-cultivated crop should precede alfalfa.
12. Crimson clover a good crop in the South to precede alfalfa.
13. A well-prepared seed bed.
14. The pulverizer is a valuable tool in preparing a seed bed.
15. Soy beans. A well-cultivated field needs little further preparation for alfalfa.
16. Liming experiments.
17. Lime or no lime. Wisconsin.
18. A strip of blue litmus paper is placed between the parts of a ball of soil.
19. A decided pink color indicates acidity.
20. Limed and unlimed fields. Kentucky.
21. Equivalents for correcting acidity.
22. Spreading lime.
23. Fertilizing experiments on alfalfa.
24. Home mixing of fertilizers.
25. Alfalfa plant, showing nodules.
26. Inoculated and uninoculated plant.
27. Taking soil for inoculation from a sweet clover patch.
28. Liquid culture with instructions for inoculating alfalfa seed.
29. Yields from inoculated and uninoculated fields of alfalfa.
30. Showing the branching tendency of the roots of Grimm alfalfa on the right.
31. Turkestan alfalfa seed, showing Russian knapweed.
32. Alfalfa seed, showing yellow trefoil.
33. High-grade and low-grade alfalfa seed.
34. Dodder on red clover.
35. Alfalfa seed and dodder seed.
36. Chart showing actual cost of adulterated alfalfa seed.
37. Simple outfit for making purity test.
38. Simple method for making the germination test, showing samples of good and poor alfalfa seed.
39. A small seed disk drill.
40. Good field of young alfalfa.
41. A patchy field of alfalfa.
42. Harvesting so long delayed that new shoots will be cut off and the stand injured.

No. of view.

43. Side-delivery rake.
44. Alfalfa in cock protected by canvas covers.
45. Alfalfa hay should be protected against damage from storms.
46. Alfalfa harrow.
47. Harrowing alfalfa.
48. Table showing digestible nutrients of alfalfa in comparison with other feeds.
49. Experimental results in feeding alfalfa to dairy cattle.
50. Experimental results in feeding alfalfa to beef cattle.
51. A better way than pasturing alfalfa.

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Unnumbered circulars on alfalfa may be obtained from the Office of Forage Crop Investigations, Department of Agriculture.

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